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Study of Thinner Thick Gaseous Electron Multiplier

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5th Micro-Pattern Gas Detector Workshop

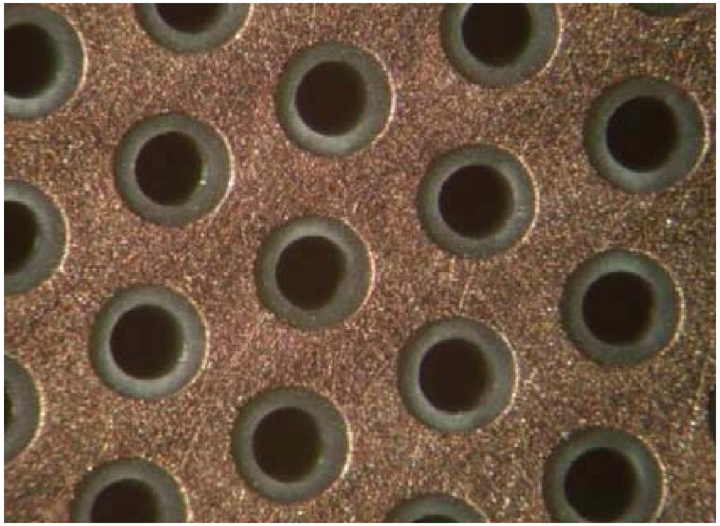
Outline

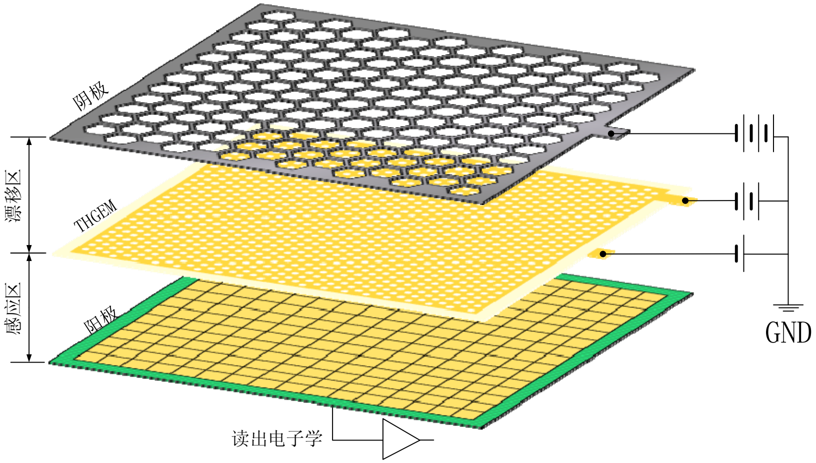
- Introduction
- Spatial resolution
- Sealed chamber
- Summary

Thick Gaseous Electron Multiplier (THGEM)

- THGEMs
  - Thickness t = 0.4～3 ㎜
  - Hole diameter d = 0.3 ～1㎜
  - Pitch a = 0.7～7㎜
- Robust
- Can be cascaded for higher gain
- Effective single-photon detection in cascade + photocathode
- Few-ns RMS time resolution
- Cryogenic operation: OK
- Sub-㎜ spatial resolution (for t=0.4㎜, d=0.5㎜, a=1㎜, spatial resolution is 0.7㎜)

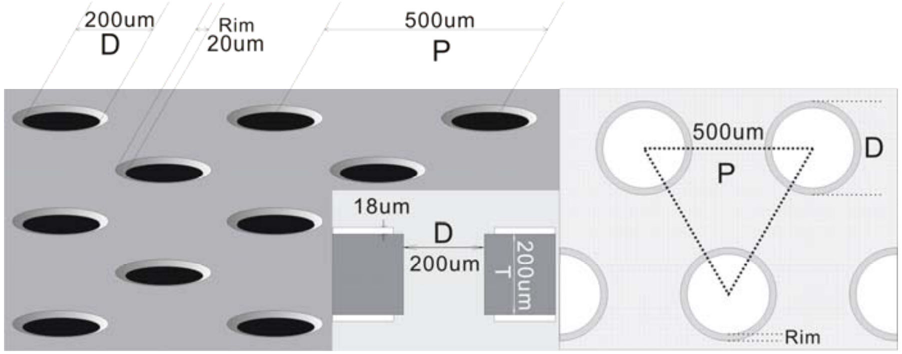
*L. Arazi, DARWIN meeting WIS Jan 2015

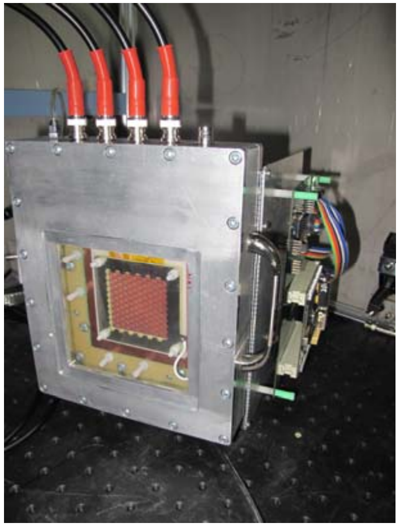




Thinner-THGEM

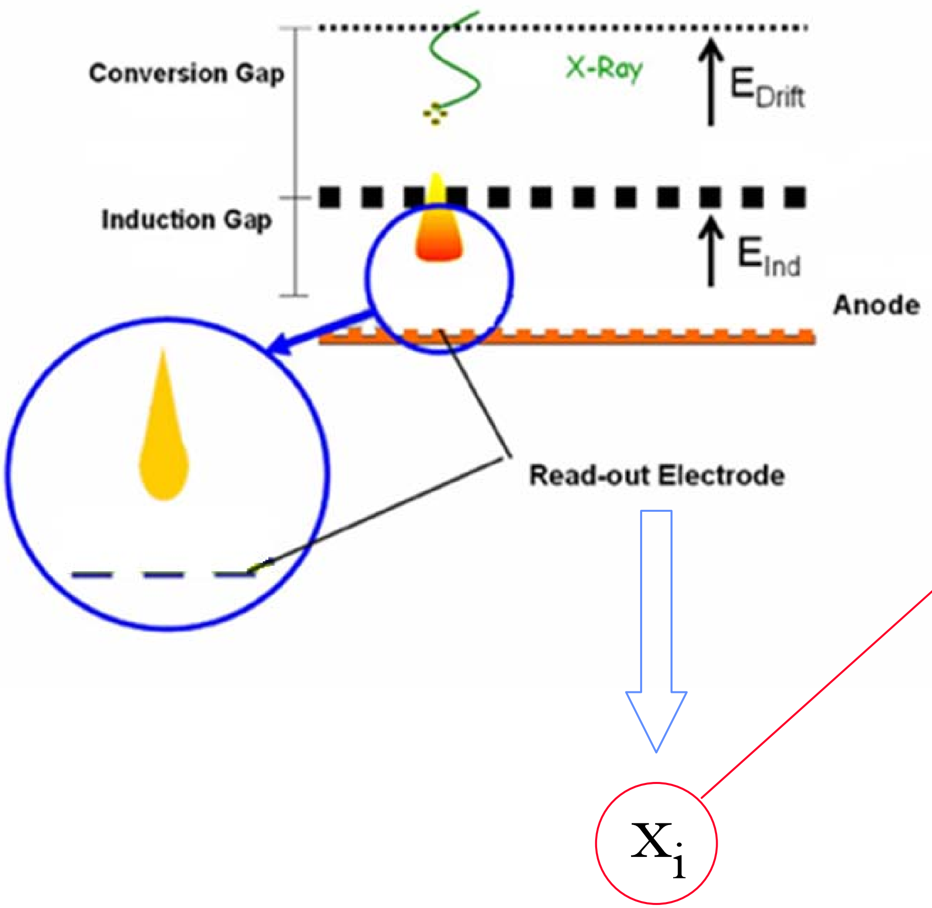
- Thinner-THGEM: t = 0.2 ㎜, d = 0.2㎜, a = 0.5㎜, rim=5～20μm.
- Thinner-THGEM chamber: active area of 5×5㎝².





- Advantages:
  - Under the conditions of obtaining the same gain, the operating voltage is lower.
  - It is easy to curve. So it can be used for one-dimensional X-ray diffraction imaging.
  - Better spatial resolution.

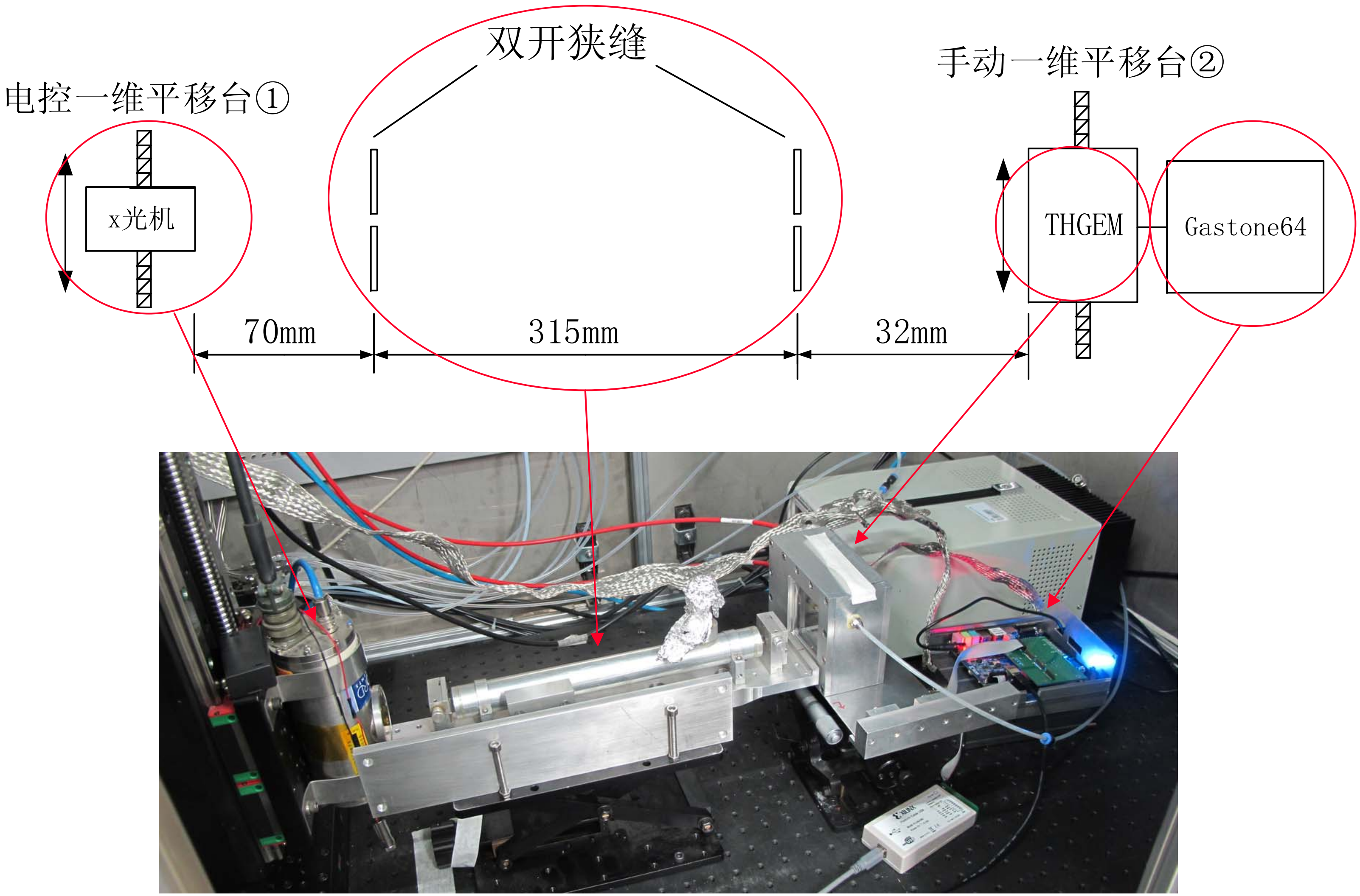
Spatial resolution



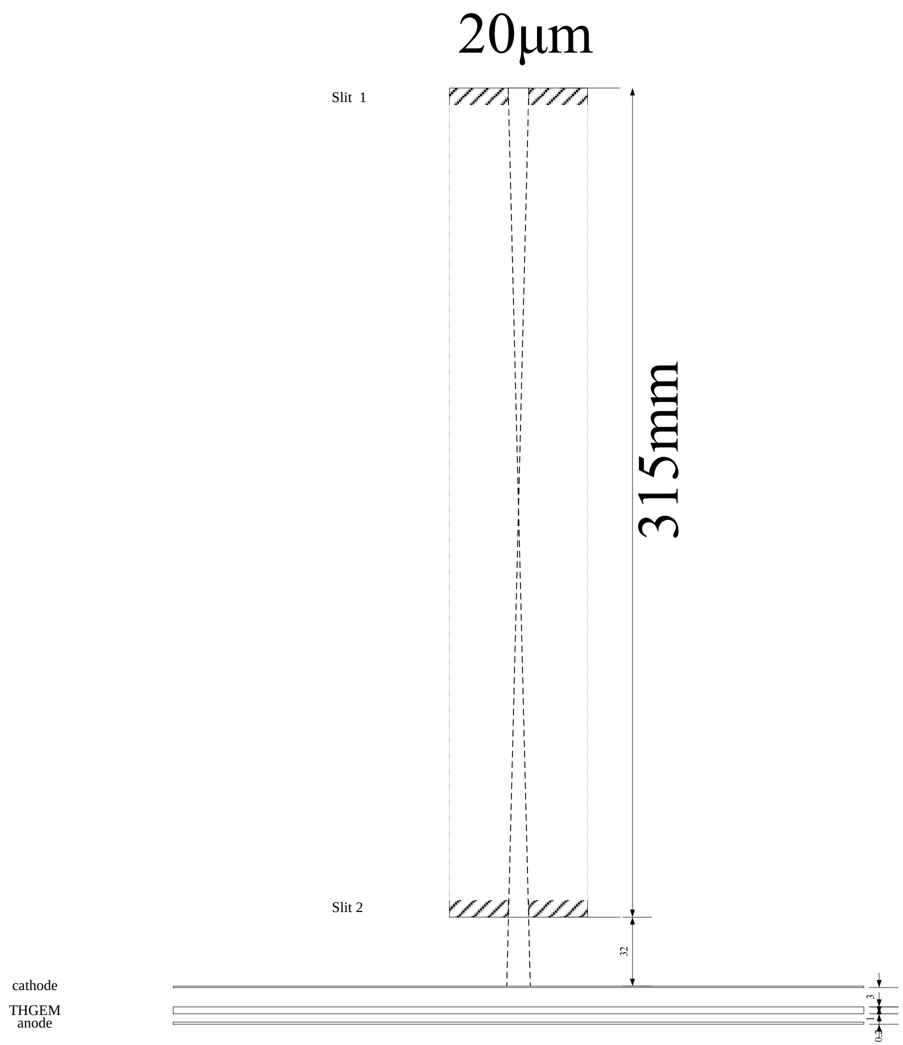
$$\sigma^2 = \frac{\sum (x_i - \bar{x})^2}{N}$$

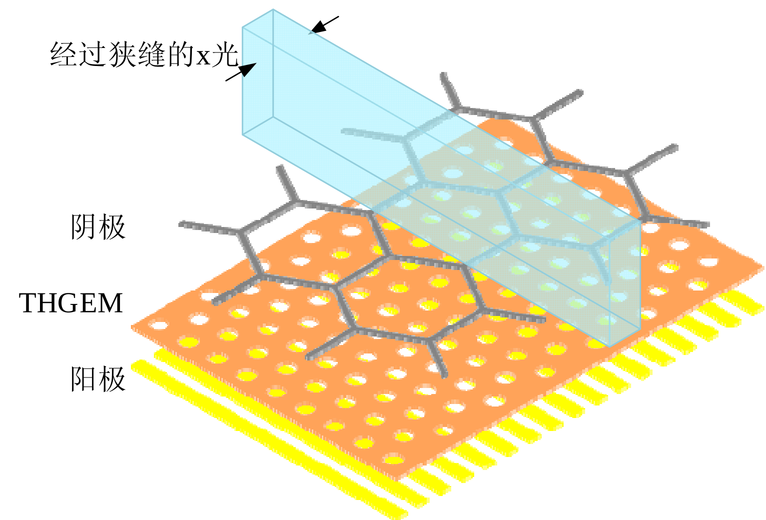
- Impact factors
  1. Structure of cathode
  2. E_{drift}
  3. THGEM’ s parameters
  4. E_{Ind},
  5. Anode straps’ size
  6. Electronics

Experiment setup



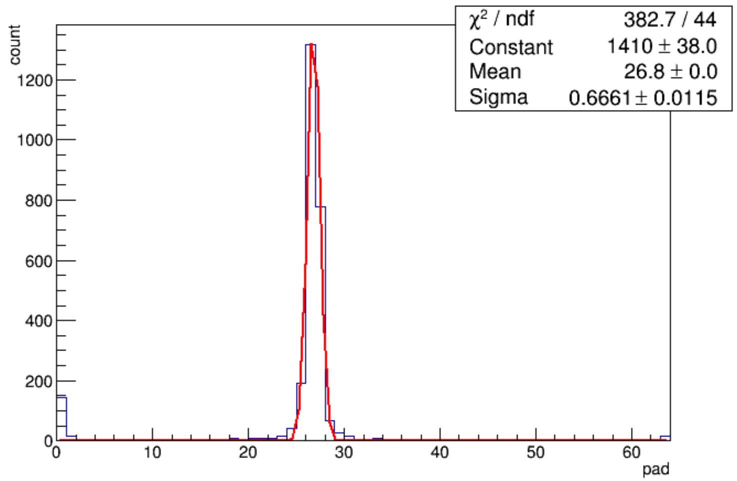
Test procedure

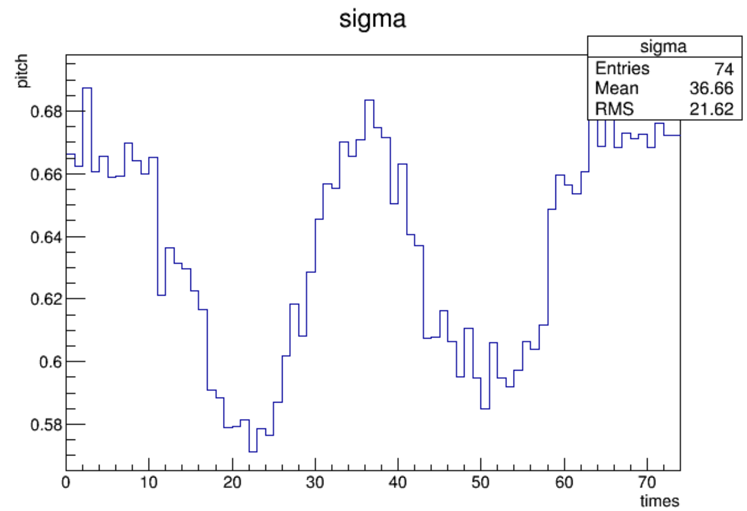




- THGEM: 150μm/300μm
- Anode: 150μm/300μm
- We deem x_0 is the middle of the slit (the width of slit is 20μm)

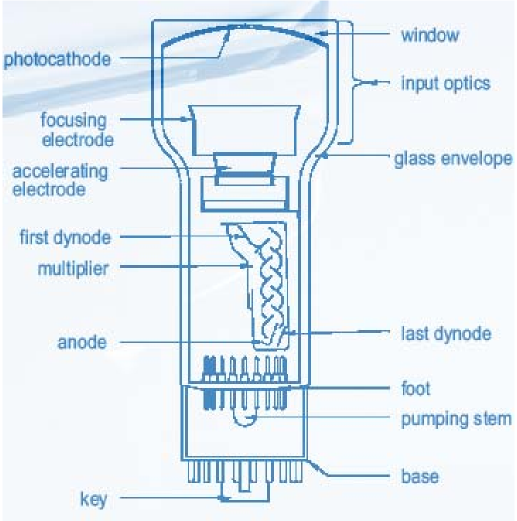
Centers method

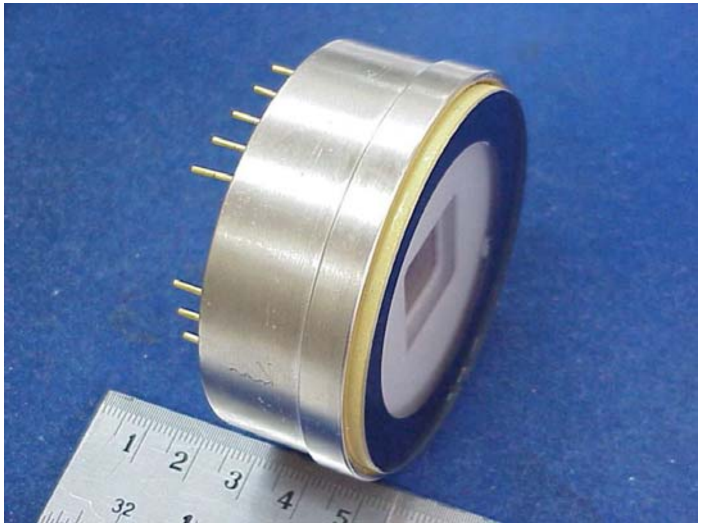




- Event by event.
- Digit signal
- Gastone64 read out.
- σ_{min}=0.5712×300 μm=171.36 μm
- σ_{max}=0.6917×300 μm=207.51 μm

Photo Multiplier Tube (PMT)

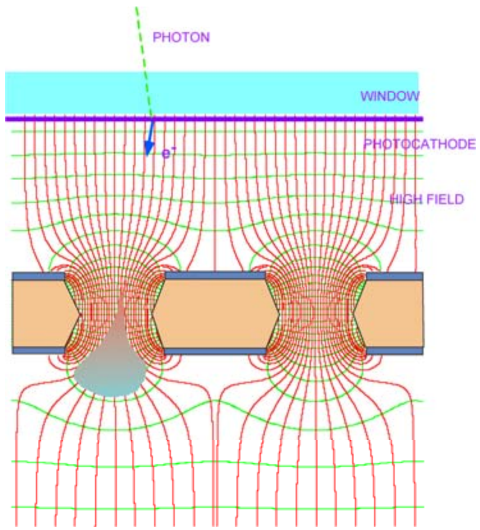


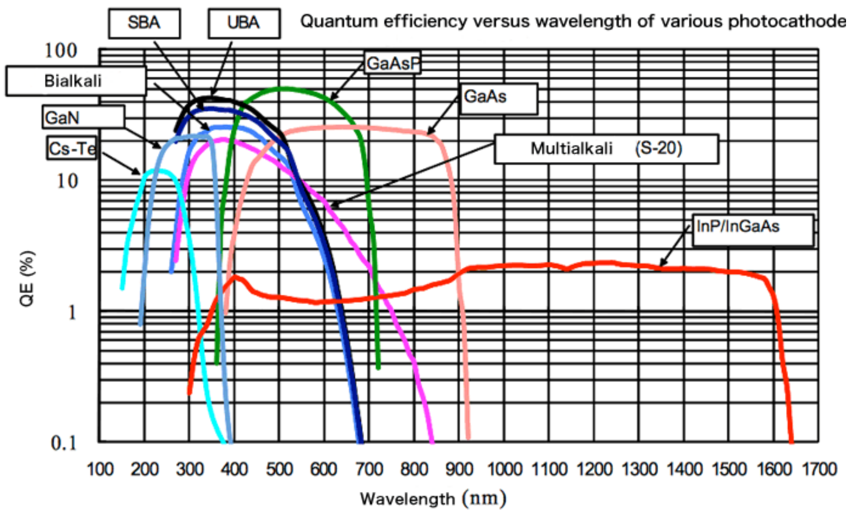


- **PMT**
  - High Gain
  - Excellent time resolution (ps)
  - Output channel limited
  - Magnetic field deflected
  - Expensive
- **GPM**
  - large areas, flat geometry
  - operation in magnetic fields
  - sensitivity to single photons
  - spectral range from UV to visible
  - fast (ns range)
  - high localization accuracy (sub-㎜ range)

Seal

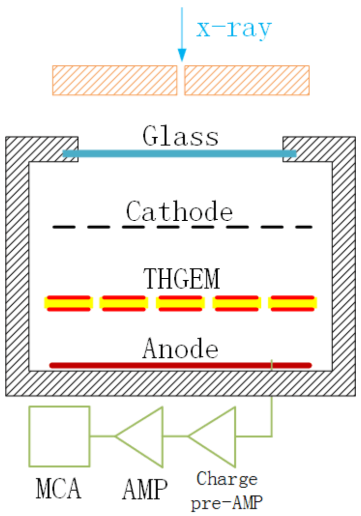
- Visible light
- Semi-transparent photocathodes
- K-Cs-Sb photocathodes are very chemically reactive and decay promptly. Therefore, detector comprising bialkali photocathodes must operate in a sealed chamber.
- Astrophysics (Atmospheric Cherenkov), medical applications, …

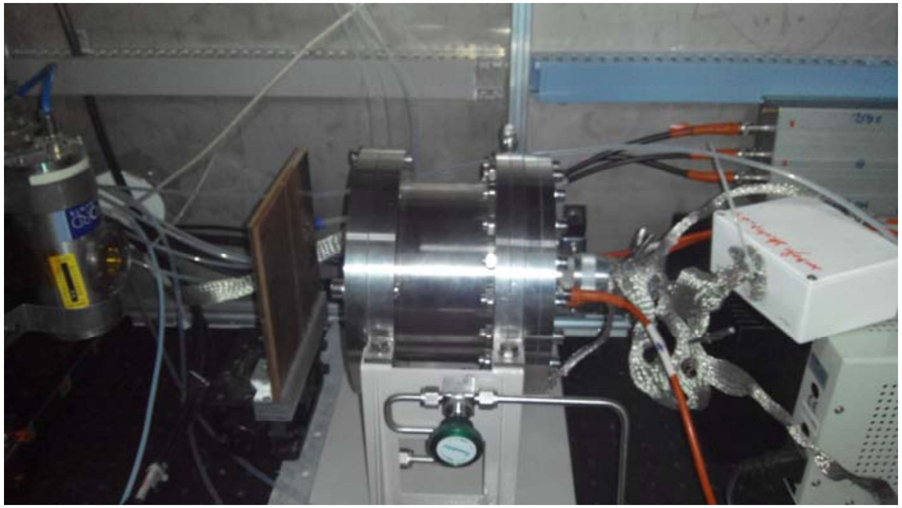




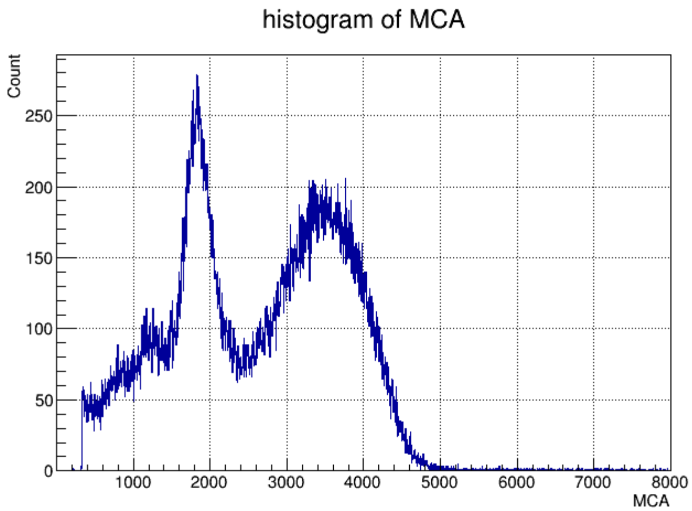
Experiment setup

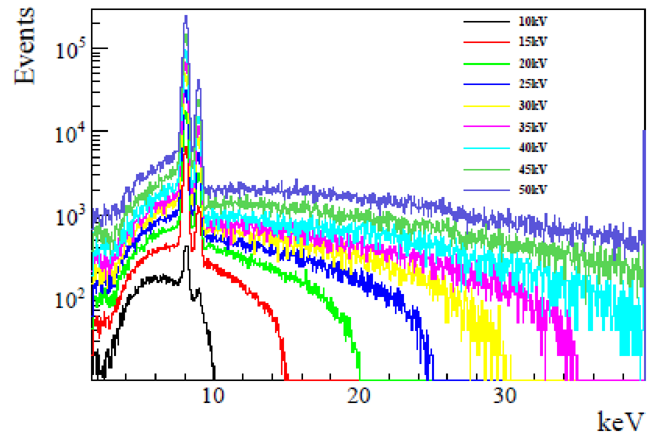
- We designed a small sealed chamber to study various types of anode, outgas of THGEM foils and so on.
- The front end uses a quartz of ⌀80×2㎜ as the transparent window. Use the aciculiform valves to seal.
- Chase leaks with He. (10^{-10} Pa×m^3/s)
- Ar (97%)+iC_4H_{10} (3%)

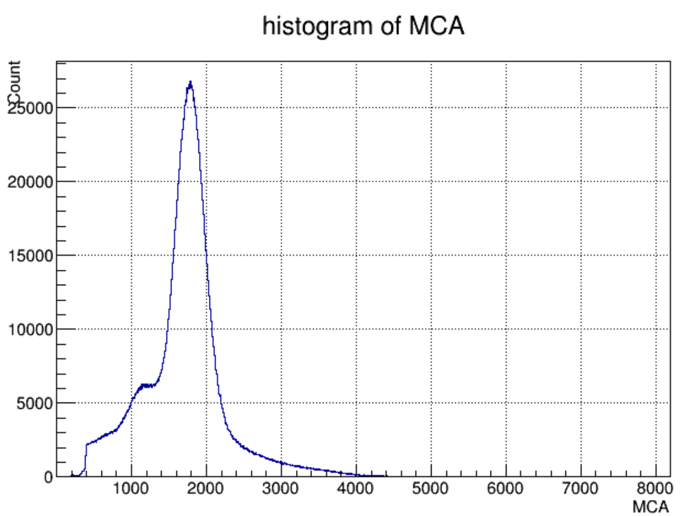




X-ray Spectrum

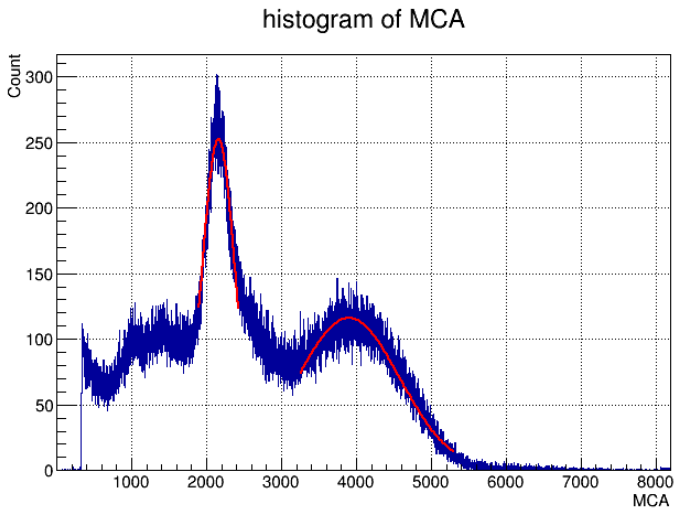


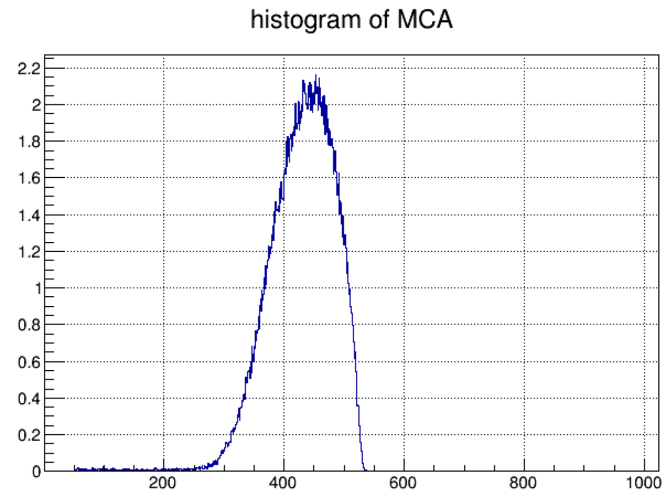


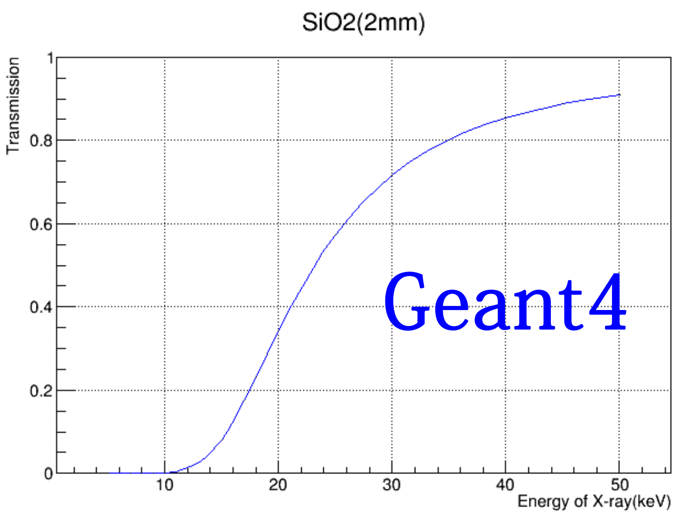


- Cu spectrum by gas flow THGEM detector: full-energy peak and escape peak.
- Cu spectrum by CdTe detector: 8.04 keV (K_α, 80%) and 8.9 keV (K_β, 20%).

X-ray Spectrum

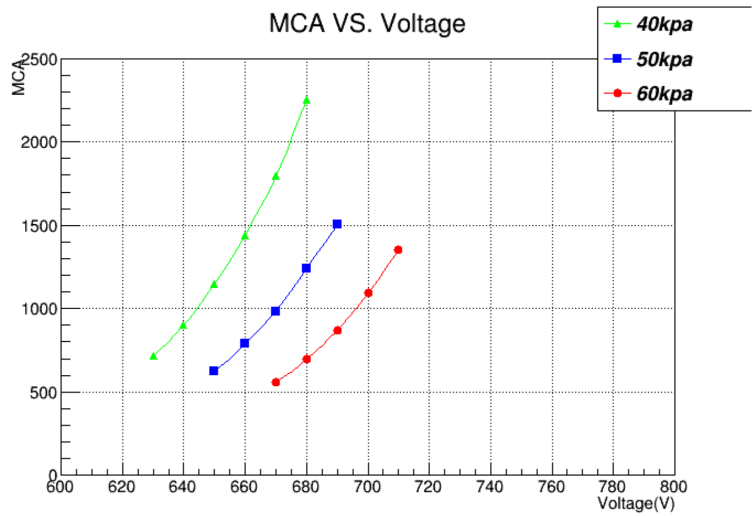


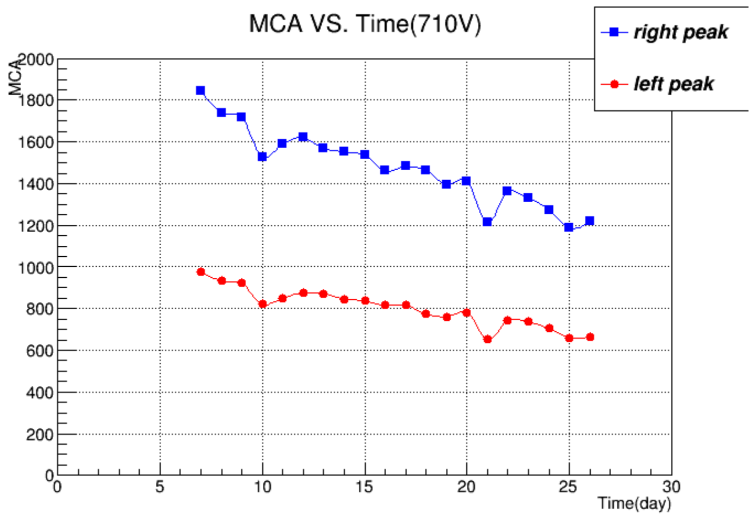




- High energy Bremsstrahlung photons which come from the X-ray tube, can transmitted through the quartz window, and hit the copper layer of the THGEM foil.

Gain





- The bigger the pressure of the chamber, the gain is smaller.
- Long-term stability. The data were obtained at a pressure of 60 kPa.
- Pressure remain unchanged.
- The gain decreases ~30% in 20 days.

Current state

Summary and next plan

- Spatial resolution: $\sigma = 171.36\,\mu\text{m}$ (Centers method).
- Preliminary study sealed chamber.
- We will further study center of gravity method.
- We will further study the technology of coating alkali-antimonides.

Thank you!